GAS IN INDUSTRY

Supplement to the "GAS JOURNAL"

Vol. 1 **No. 8**

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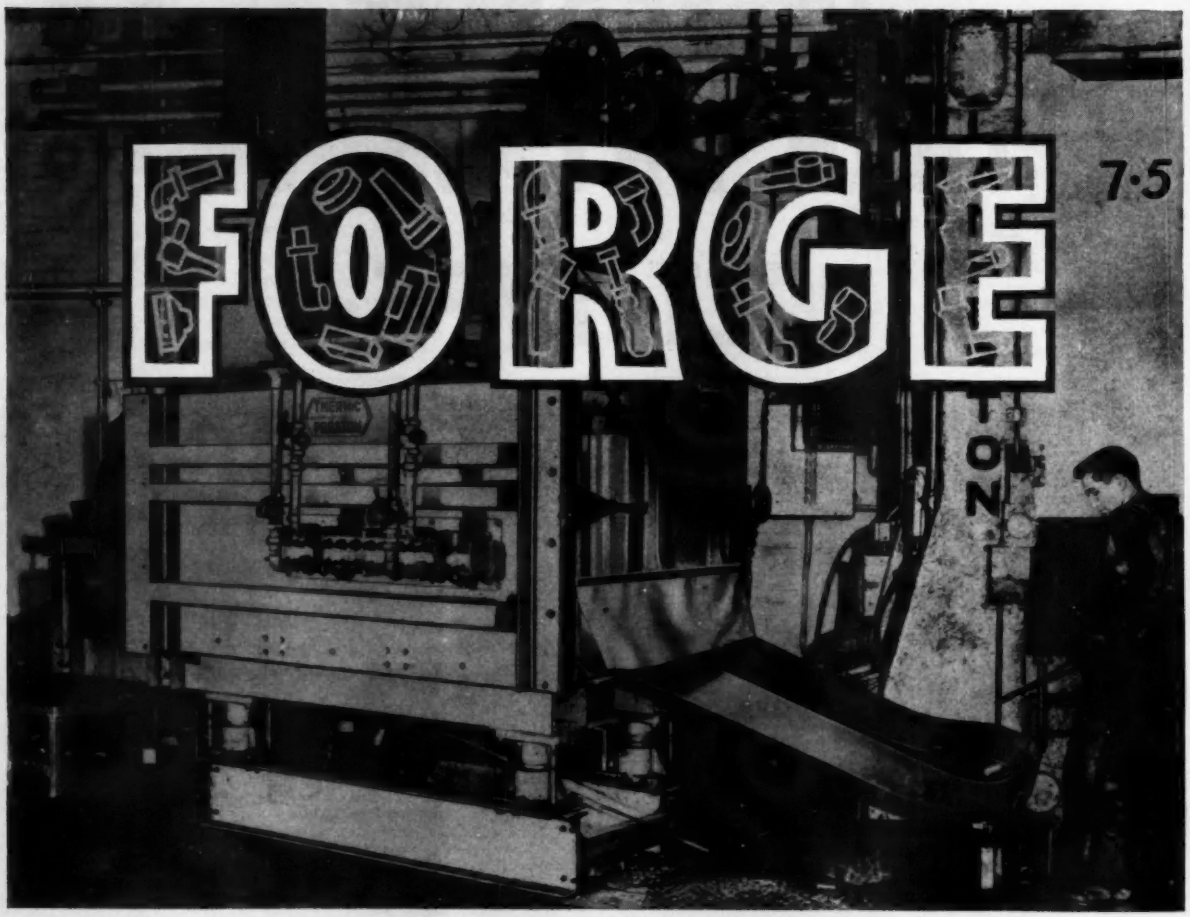

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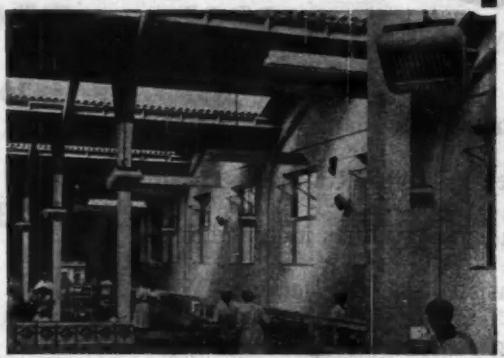

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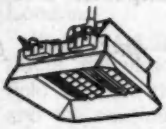

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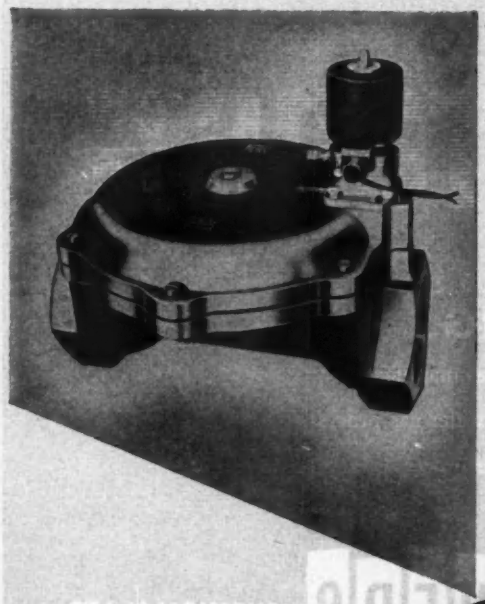

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GAS IN INDUSTRY

DEC. 1958

Vol. 1 No. 8

FEATURES

WATSON HOUSE INDUSTRIAL LABORATORY AND WORKSHOP— an exclusive 'GAS IN INDUSTRY' article.

BAKING TRENDS IN THE NORTH WEST.

THE LABORATORY IN INDUSTRIAL GAS PRACTICE. By C. P. Henshilwood and R. H. Wharton.

GASTRONOME DISCUSSES CHIP FRYING

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Editorial

Yardstick of Perfection

WHEN the British industrialist buys gas-fired heat processing equipment he may be sure, through the services of the Gas Council and area boards, that not only will the appliances be of standards measured by the yardstick of perfection—in quality, performance, economy and safety—but also that they are precisely for his particular purpose.

Should there be any doubt about the length and breadth of the services available, let them be dispelled by a reading of the two features in this issue based on the work of the Industrial Laboratory at Watson House, London.

In addition to the experience and traditional integrity of the manufacturers, the nationalised sector of the industry has representatives in this field who are themselves picked for their devotion to technical perfection and the continuance of service after sales. It is what the representative represents, however, which is often not fully appreciated. Through the Industrial Gas Bureau of the Gas Council, the knowledge and experience of every industrial gas engineer in Britain are channelled. As the article on p. 194 sums up: 'The Laboratory and Workshops provide a complete service for industry from the theoretical and drawing board stages to maintenance of the finished article.'

More specifically, the Laboratory researches into fundamental problems, develops new equipment, interprets and publishes data, examines appliances and subsequently submits suggestions. Finally, and with spectacular success, it solves customers' individual requirements.

The drying of a stuffed elephant could certainly be called spectacular. But so could a more substantial example, given in a paper by Mr. C. P. Henshilwood and Mr. R. H. Wharton, where gas heated plant at the premises of a large-scale consumer was surveyed, involving three days test work by nine Watson House staff, 'reconnaisance visits' by senior staff and others, and the accumulation of test information for the 'construction of a complete heat balance.' As a result the management have been presented with a set of proposals which will help the considerable stepping up of efficiency.

The Industrial Laboratory at Watson House is the nucleus of the effort that has seen to it that there are an estimated 4,000 applications of gas in industry; and that confidence in gas has brought sales of this fuel in industry up by 33% since 1950 to 786 mill. therms in 1957-58—an expansion partly due to the natural growth of industry generally, of course. But, as Mr. A. E. Tyrrell, North Thames Gas Board, said in a discussion to the paper by Henshilwood and Wharton: 'In June this year industrial production in Britain was down by 3%, as compared with the same period of last year. In August it was 7% down, and at present, with the decline in world markets continuing, there seems little hope of improvement. Yet the demand for industrial gas in North Thames is higher by nearly 6% for the same period.' The truth is that more and more industrialists are finding that the 'ilities' of gas—adaptability, reliability, and flexibility, chief among them—make it overwhelmingly the right fuel.

They have to know it all in Watson House Industrial Laboratory and Workshops

WHAT is dragon's blood? When is a lump of metal an ingot—a slab—a billet? What are flongs? What's a piglet creep?

And just what is all this? Not, as may have been surmised, a new 'GAS JOURNAL' parlour game; but just a few of the vast number of trade terms with which those responsible for the Watson House Industrial Laboratory and Workshops must be familiar.

For the laboratory and workshops are at the disposal of industry to develop, design, and construct special gas-fired heating equipment not available from the manufacturers, or to improve existing equipment.

So Mr. E. A. K. Patrick, in charge of the laboratory, and Mr. H. W. Grover, in charge of the workshops, have, over the years, acquired—and, indeed, found it necessary to command—at least a smattering of the jargon used in virtually every industry in the country.

Mutual understanding

In fact, they need a good deal more than a smattering of industrial jargon. In their work they must be able to talk on terms of easy mutual understanding with a wide range of people with whom they come into contact.

They must also be able to tackle the seemingly impossible task of developing equipment for the customer who is unable to explain, and perhaps does not altogether know, exactly what he wants—they have even developed equipment with nothing more to work on than a picture and a vague description of something seen in operation in another country!

EXCLUSIVE TO 'GAS IN INDUSTRY'

ALL PHOTOGRAPHS TAKEN BY OUR STAFF PHOTOGRAPHER

They must be able to discern when the customer is, perhaps unwittingly, exaggerating his requirements; or when he is blaming his existing gas-fired equipment for not doing efficiently something for which it never was designed.

When developing a piece of apparatus, they must know just when to invite the customer along to see what they have done so that they neither shake his confidence by showing him too little, nor risk going too far in the wrong direction. They must be able to decide whether a certain process can be developed in the laboratory and workshops or whether the problem must be tackled in the factory. They must be prepared, too, to go to a factory and carry out a survey of heat usage with the object of recommending modifications of plant or procedure to save gas.

Of course, not all industrial gas problems go to the Watson House Industrial Laboratory and Workshops. Many cases are satisfactorily dealt with by the appropriate industrial representative. If the industrial representative needs assistance he calls upon the industrial engineer. Only when the industrial engineer decides that research and experiment are needed does the problem go to the laboratory.

Trade secrets

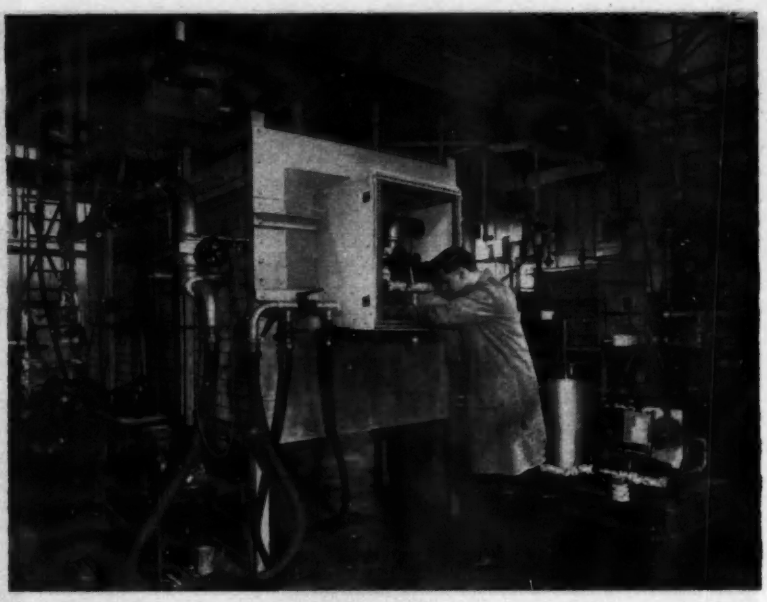
It would be interesting to describe some of the highly specialised equipment that has been developed. But much of the work is carried out for individual firms, and to make public what has been achieved would be to betray trade secrets to these firms' competitors.

However, it may be said without damaging anybody's interests that problems successfully tackled have

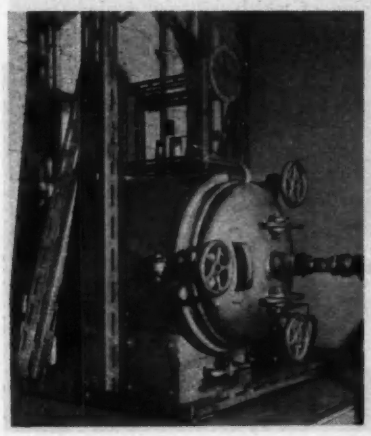
included the firing of letters on ampoules and hypodermic syringes, the ripening of bananas, the annealing of glass and aluminium, and the drying of *papier maché* and skeins of silk. And—in what Mr. Patrick calls the 'crazy department'—a way was sought to make the inside of a bottle hot yet leave the outside cool enough for a girl to pick up without burning her fingers; Chinese hotplates were developed (chop suey lovers, please note); and—back to where we came in—piglet warmers were converted to gas (for keeping piglets comfortable in piglet creeps).

Problems to be solved

However, life in the laboratory and workshops is not one long joke. Problems have been solved and equipment developed and constructed involving temperatures ranging between −10° F. and 2,000°C. in furnaces varying very considerably in size from quite small appliances up to large installations.



Furnace in use for trials of combination burners.



Apparatus for determining rate-of-drying curves on consumers' samples.

There are said to be 4,000 industrial processes in which gas is used. There are three basic ways in which gas may be burned—mixed with air before, at, or after the burner port. And there are two ways in which the resultant heat may be employed—convection and radiation.

This, says Mr. Patrick, is perhaps an over-simplification; and there are 'more tricks of the trade than that.' But it is the basis on which all research and development is carried out.

The work of the laboratory falls under four main heads: Research—Development—Consumer Problems—Appliance Examination.

Proprietary backing-up pot submitted for test.

Proprietary direct-fired 12 therms per hour process air heater under test.

Research consists of long-term work on basic problems. It is, of course, applied research which must be distinguished from the pure research which is the prerogative of the universities and other research organisations with which Watson House maintains close contact.

Urgent needs

Research work is done for the London Research Station of the Gas Council to which the programme and progress of work are submitted annually. This, and discussions with the Industrial Gas Development Com-

This recuperative furnace has achieved temperatures as high as 2,000°C.

mittee, aid the co-ordination of the work in relation to other laboratories and the most urgent needs in the industrial field.

Under the heading Development falls work concerned with the production of new apparatus or methods likely to be of value to a general market. Against this, Consumer Problems comprise a technical development service for a specific customer.

Appliance examination scarcely requires elaboration, except, perhaps, to point out that the industrial gas appliance is not mass-produced as is its domestic counterpart. It is an individual piece of apparatus. More flexibility must be allowed in the appraisal of its performance.

Watson House, as a whole, prides itself on constructive appliance testing. Every attempt is made to show the manufacturer how to correct faults and how to improve performance even to the length of rebuilding his appliance for him in the workshops.

Big savings

But whereas in the realm of domestic appliances, high experimental costs will be made good in quantity sales, the industrial laboratory and workshops may devote much time and money to the development of equipment from which little immediate return can be expected. On the other hand, there is the occasional development of some very large item of equipment, the perfection of which will entail big savings, and money and energy dissipated without obvious tangible return are not always to be looked upon as losses: Often the knowledge gained may be of considerable future value.

Clock repair shop.

It is part of the Watson House service that if specialised knowledge is required which is believed to be available somewhere in the country, an enquiry will be circulated through the Industrial Gas Development Committee of the Gas Council so that the entire resources of the industry are tapped.

Industrial appliance demonstration room.

Most frequent problems

Scientific problems most often encountered concern heat transfer, aerodynamics, temperature, flow measurement, and gas analysis. There is also a constant search for improved furnace construction materials. It is relatively easy to make a furnace hot —the question is: Will it stay in one piece?

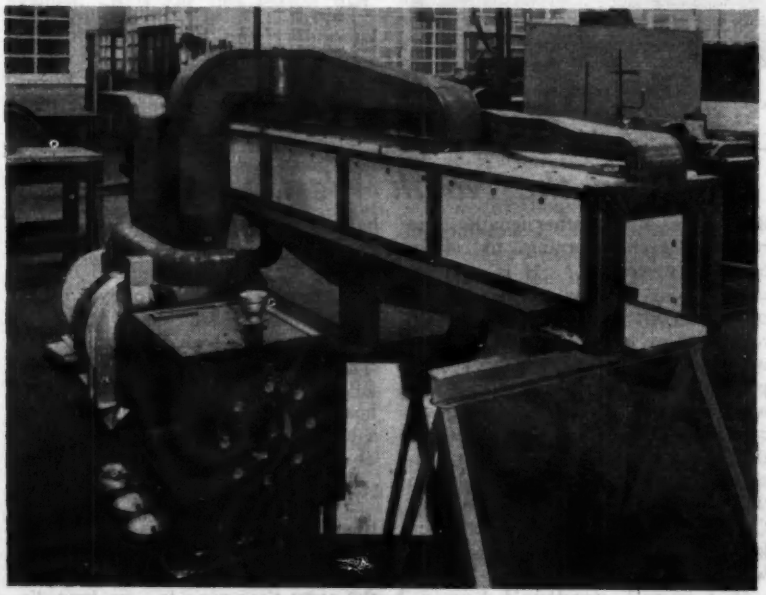
Whenever possible Watson House circulates reports on the results of

Industrial appliance showroom.

development work through the Industrial Gas Development Committee. For reasons already explained, many of such reports are confidential, but whenever the necessary authority can be obtained they are circulated without restriction. Close liaison is maintained with the Society of British Gas Industries through the Industrial Gas Development Committee.

Another field in which research goes on continuously is in the interpretation, in terms of gas, of developments taking place in other fields. Attention has been devoted recently to reducing noise in gas equipment. An unfavourable impression is abroad that electric equipment is quieter, emits less heat and looks better than its gas heated counterpart, and is therefore more acceptable to the worker. This is not always true, but wherever there is some truth in it, it is being tackled. But the order of importance is always safety first, then efficiency and ease of maintenance, and then appearance.

Construction of an oil boiling furnace.



Construction of a drying tunnel showing the air-blowing fan and gas-fired air heater.

Building of equipment

In the well-equipped industrial workshops, research carried out by the staff of chemical and gas engineers, chemists and physicists in the laboratories is given expression in the building of equipment—even down to Chinese hotplates! But no equipment is built in these workshops if it is available from the usual manufacturers or if a manufacturer is prepared to build it. In other words, the

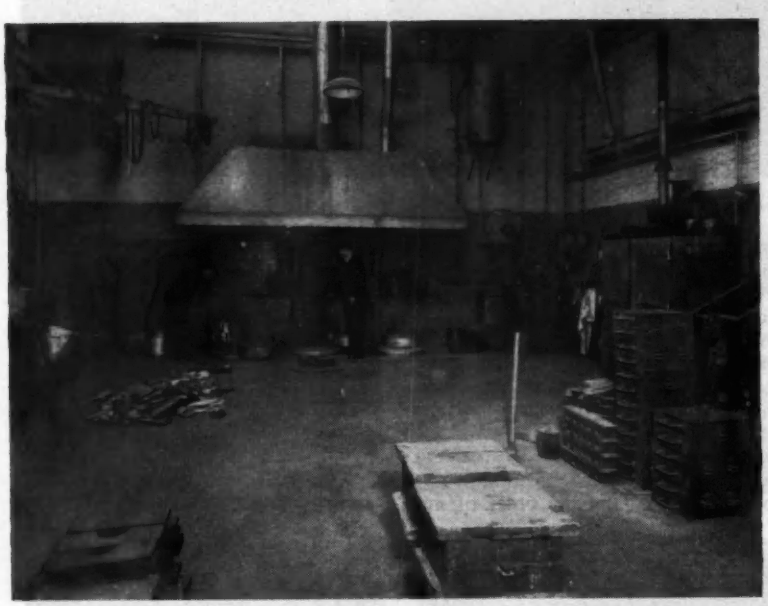
workshops are not in competition with the manufacturers.

An important part of the workshops is the industrial gas equipment showroom, the largest in the industry. Being in London, the showroom sets out, in particular, to exhibit appliances most likely to be of interest to industrialists in the area.

Manufacturers are invited to exhibit in the showroom gas-fired equipment which they have produced. And whenever something new is added to the display, industrialists to whom it might be of interest are invited to call and inspect it by the industrial sales organisation of the Board.

In addition, parties of industrialists are invited at frequent intervals to inspect the showroom. On these occasions the visitors frequently see some item of equipment of the availability of which they were unaware with the result that unexpected business is transacted—and more gas sold. Even if there is nothing of special application to their needs in the showroom at the time, their attention is frequently attracted and their special interest aroused by one of the many illustrations which are displayed on the walls of the showroom.

Rebricking of an assay furnace.



Foundry showing three gas-heated pit type crucible furnaces and a core drying oven.

Included in the workshops are an electric welding shop, foundry, and sheet metal works. There is also a refractory brick cutting room, and a special point is made of giving visitors information regarding the different bricks available for various applications.

Where a special piece of equipment has been developed and is not available from other sources, a supply of spares is kept in the workshops so that the customer is never left with his equipment out of commission.

Thus the Watson House Industrial Laboratory and Workshops provide a complete service for industry from the theoretical and drawing board stages to maintenance of the finished article.

Baking trends in the North West

TO coincide with the North Western Federation of Master Bakers' Annual Conference, the North Western Gas Board arranged a small exhibition of bakery equipment in the Board's Church Street Service Centre in Blackpool and entertained 61 wives of the delegates.

In the Board's area the most popular choice among family bakers has hitherto been the indirectly heated hot-air type 'Peel' oven. These ovens are usually of heavy brick construction and, with certain exceptions, differ very little in design from the earlier ones which were built for solid fuel.

An outstanding characteristic of these ovens is the rather lengthy time required each morning to attain baking temperature. It is not uncommon for the gas to be switched on shortly after midnight in order to reach baking heat by 6-0 a.m. It is, of course, true to say that this system puts a lot of heat into the oven brickwork which, under certain conditions, can be usefully employed. Indeed, this 'solid heat' was in the past considered essential in order to deal with the bread and pie trade each morning. Confectionery and 'smalls' were then baked on a falling temperature often with the gas turned off.

Although some of the smaller bakers continue to bake bread, particularly special varieties, the majority of this trade is now handled by the large plant bakers. It follows, therefore, that the family baker who now concentrates on high-class confectionery, etc., is no longer able to take full advantage of the 'stored heat' in the heavy brick ovens and this results in a lower operating efficiency and quite obviously a higher relative fuel cost.

Many bakers have already realised this and installed gas-fired ovens which have been designed to give a rapid heat-up period each day and at the same time provide even heat distribution.

The laboratory's function in industrial gas practice

by
C. P. HENSHILWOOD
B.Sc., A.R.C.S., A.M.I.CHEM.E.
and
R. H. WHARTON
ASSOC.INST.GAS E.

THE increasing importance of sales of gas to industry in the face of increasing competition is the background to all the work of the Industrial Laboratory at Watson House. In 1950-51 the sales of gas to industry accounted for 590 mill. therms, but by 1957-58 this has risen to 786 mill. therms, an increase of 33%. It is intended in this paper to show how the laboratory operates in assisting the promotion of industrial gas, and examples will be included to illustrate this theme. It will be shown that most of the work of the laboratory requires, at one stage or another, consideration of design.

The cost of fuel used by any consumer constitutes part of the value of the article being manufactured and it is important that it should be used in a safe manner and in a way consistent with the economics of the process. To enable this to be done, the appliance manufacturer or plant builder should be fully conversant with the potentialities of the fuel which his equipment is designed to use. The industry is only too well aware that there are appliances capable of doing the duty intended, but which are greatly extravagant in fuel and in some cases potentially dangerous.

PARTICULAR RESPONSIBILITY

In industrial and commercial fields where appliances are required for specialised applications the use of mass production methods is seldom justified. It is for this reason that manufacturers of such equipment are frequently faced with the problem of combining sound gas practice with individually designed appliances. Thus it is that the gas industry has a particular responsibility in helping these manufacturers and the consumers using this equipment. In addition, if unsatisfactory equipment is installed, the prestige of the gas industry as a whole will fall.

In view of the wide range of requirements, most proprietary industrial gas appliances are sold directly to consumers by the manufacturers and for this reason there is no industrial counterpart to the Gas Council Approved List of Domestic Appliances.

Determination of performance calls for careful consideration and it is particularly important in the industrial field that a correct basis is established. Unnecessary heat losses both from the flue and external surfaces must of course be kept to a minimum. Here a knowledge of the flue gas composition and temperature gives a lead in assessing the performance. In the ideal case it would seem that a carbon dioxide content approaching the theoretical value of approximately 12% would be desirable provided the $CO:CO_2$ ratio does not exceed 0.02 under heat input overload conditions, while the temperature of the flue gas should not be greatly in excess of that of the process for which the appliance is designed.

Having tested an appliance as received a further course of action has to be decided upon. If the results of the tests indicate that a satisfactory performance has been achieved with the original design then the appropriate reporting mechanism can be set in motion. On the other hand the initial tests may reveal the need for slight modification and this is normally handled in the laboratory. If, however, some major alteration appears desirable then the manufacturer may be invited to do this at his own premises and re-submit his modified appliance for further examination; in some cases this work may be carried out at Watson House with his permission.

If modifications are made to production models, either as the outcome of laboratory examination or at the decision of the manufacturers it is desirable that a production model incorporating such modifications should be submitted for test; this enables the latest performance data to be made available which may well be superior to that for earlier models.

Data obviously fundamental to an appliance are its thermal efficiency and the work processed per therm of gas used. They do not however reveal the reasons for differences in performance, which may be due to differences in heat transfer areas, or to differences in the temperatures employed. Both these types of difference involve differences in capital cost of an appliance, and a balance must always be struck between the cost of improvements along these lines and the savings to be effected by them.

The theme conveyed by the title of the paper can best be illustrated by a few selected examples each of which illustrates a particular aspect of the work. These examples are intended to emphasise the individual approach which is necessary with each appliance encountered. Three cases of increasing complexity show the various approaches that are necessary to ensure that the appliance is satisfactory not only as an industrial appliance but also as a piece of gas burning equipment.

RADIANT PANEL

To illustrate the simpler type of examination, the case may be cited of a low temperature radiant panel the construction of which is shown diagrammatically in Fig. 1. This unit was submitted by the manufacturer to the laboratory and the subsequent test programme was straightforward in that no modifications to the panel were called for. The design did however embody a hitherto unconventional feature which made it necessary to revise earlier techniques used when testing similar appliances. The usual grand finale to a series of tests on such an appliance is an attempt to construct a heat balance. This example presented some difficulty in that it was the first appliance to be tested in the laboratory in which chromium diffused finished radiating surfaces were employed. Panels

From a paper to the London and Southern Junior Gas Association, November 21.

tested previously had refractory enamel coated radiating surfaces of known emissivity but no reliable information appeared to be available giving emissivity figures for chromium diffused mild steel. It was therefore necessary to assume that after calculating the flue and surface losses, and also the convection losses from the radiating panel, the remainder would be heat given as radiation from the panel.

This method of constructing the heat balance was not entirely satisfactory in that there were other heat losses which no doubt varied. Thus by calculating the heat loss due to radiation by difference the emissivity was tacitly assumed.

Experiments were carried out by fitting, in turn, chromium diffused and refractory enamelled radiating sections into the same appliance. By this means the radiant outputs for a given heat input were compared. In order to do this a test piece was employed consisting of a 6 in. square of 18 S.W.G. mild steel sheet painted matt black and having a thermocouple attached to its centre. This was placed approximately 3 in. away from the radiating surface. The results obtained for the two surface finishes are given in Table 1.

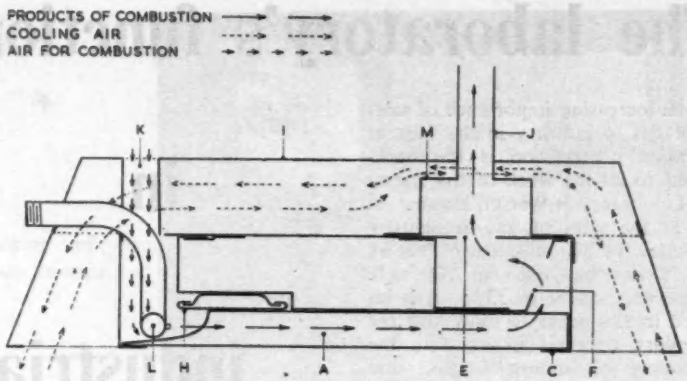


Fig. 1. Horizontal radiant panel.

and in the fashion jewellery trade for wax investment processes. One of these was in use at a school of arts and crafts and it was observed by the industrial representative concerned that combustion of the ungoverned appliance was unsatisfactory. Following this observation the manufacturer was approached and invited to submit a sample appliance to the Industrial Laboratory for examination. This offer was accepted and the furnace was duly received.

A general view of the appliance is shown in Fig. 2 from which it will be seen to consist of a refractory lined spherical chamber having a matt black painted finish and supported on a stand and heated from beneath by an ærated burner.

For the purpose of test a plaster filled cylinder was supplied which represented a normal charge for the furnace. This was supported by two straight rods placed horizontally across the lower half of the working chamber and a thermocouple was inserted in the plaster to enable the temperatures likely to be obtained in normal use to be measured.

It was learnt that the furnace charge was normally required to reach approximately 800°C. at the centre and this figure was therefore used as a target for satisfactory performance. First of all, tests were carried out to

TABLE I

	TEST I		TEST II	
	Chromium diffused	Refractory enamel	Chromium diffused	Refractory enamel
Heat input B.t.u. per hour	15,100	15,150	10,250	10,100
Panel centre temp. °F	800	655	640	490
Test piece temp.:				
Initial .. .. °F	85	80	75	76
Equilibrium .. .. °F	410	405	293	300
Time to reach 90% of equilibrium	4 minutes	4 minutes	5 minutes	4 minutes
Temperature rise	30 seconds	6 seconds	6 seconds	48 seconds
Time to reach equilibrium temperature	9 minutes	8 minutes	9 minutes	10 minutes

From these results it may be seen that the heat inputs required with each surface to obtain similar heating up rates of the test piece were of the same order in each case although the temperatures of the radiating surfaces differed considerably because of their differing emissivities. The results obtained with this appliance as received from the manufacturer were satisfactory and no modification was considered necessary. The example does however illustrate the flexibility of approach which is necessary when deciding on the techniques for examining industrial appliances.

A case where an appliance was originally unsatisfactory in its performance but was considerably improved by making certain modifications is that of a small furnace designed for use in dental laboratories

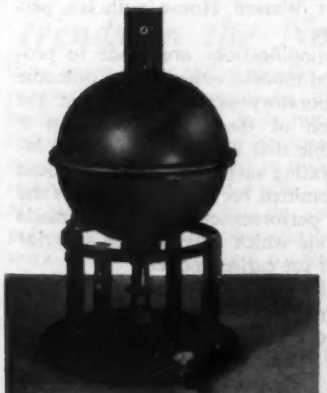


Fig. 2. Dental furnace as received.

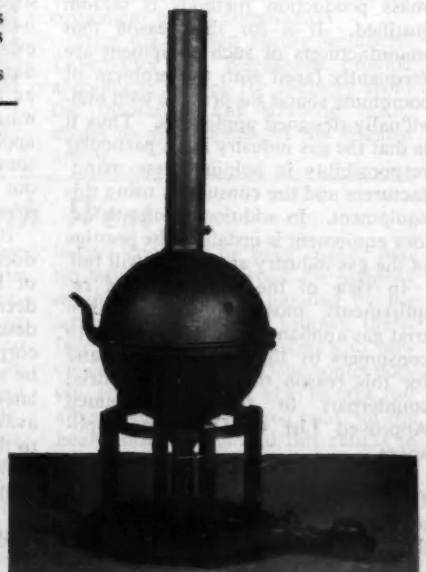


Fig. 3. Dental furnace after modification.

determine the performance of the appliance as received when operating at a maximum burner pressure of 2.5 in. w.g. Having done this, three modifications were made, one at a time, as listed below:

(1) Flue extended.
(2) Exterior of furnace painted with aluminium paint to reduce heat loss by radiation from the external surface.
(3) Burner tube enlarged to improve the æration of the flame in accordance with recommendations made by J. A. Prigg.

The results obtained under each of these conditions are shown in Table II. Having progressed so far it was felt that it would be unnecessary to make any structural alteration to the appliance. Further tests were therefore confined to establishing the maximum heat input that could be recommended. In order to do this several combustion tests were carried out to enable a limiting rate curve to be plotted. From this the heat input at which the $CO:CO_2$ ratio reached 0.02 was determined to be 16,500 B.t.u. per hour and therefore to enable the appliance to comply with the combustion requirements of B.S.717 the rated heat input was taken as 13,750 B.t.u. per hour.

Fig. 4. Gas heated autoclave.

TABLE II

	As received	After modification		
		1	2	3
Maximum temperature °C	760	790	800	807
Burner pressure in. w.g.	2·6	2·5	2·6	2·4
Gas rate cu. ft. per hour	22·6	29·5	26·1	27·4
Heat input B.t.u. per hour	11,300	14,950	13,150	13,400
Flue gas analysis :				
CO_2% ..	9·3	10·9	10·7	9·7
O_2% ..	3·8	0·8	2·0	3·0
CO% ..	nil	nil	nil	nil

REDESIGN NECESSARY

Another aspect of the work of the laboratory is illustrated by a case in which redesign was necessary as well as examination of the appliance. An autoclave was designed by a well-known manufacturer of laboratory equipment; however heated, the external casing and the pressure vessel and its fittings were to be similar. The laboratory was of course concerned with the gas-heated model, and the manufacturer wished to improve the burner arrangements in his already successful appliance. This involved some redesign of the combustion chamber. The method of ignition also presented some difficulty and the assistance of the laboratory was sought to solve this problem.

The appliance as received for test is shown in Fig. 4. It consisted of an autoclave heated from beneath by a circular burner fitted with post ærated jets with ceramic tips, and housed in a conical combustion chamber. Gas to the burner was controlled by a constant pressure governor, thermo-electric flame failure device, and indirect acting thermostat. The appliance had a mild steel outer case and was mounted on four rubber-tyred castors to enable it to be moved easily.

The combustion chamber was formed by a cylindrical shell 5 in. deep having a frustro-conical base of 8 in. vertical depth constructed from mild steel sheet and lined with a ¼ in. layer of soft asbestos sheet. This shell was fitted over the base of the autoclave and rested on three supports as seen in Fig. 4. The top of the shell was sealed to the exterior of the autoclave with asbestos rope as may also be seen in Fig. 4. The burner was fitted just inside the bottom opening of the cone which was 9 in. diameter. A 3-in. diameter flue outlet was taken off at the back of the cylindrical portion of the combustion chamber. This outlet extended horizontally through the back of the appliance case to allow the fixing of additional flue if necessary.

An automatic gas cooker lighter of the hot catalyst type had been supplied for ignition as an integral part. Tests on the appliance as received showed that the performance was satisfactory but the manufacturer felt that stainless steel jets would be less likely to become choked than those originally fitted.

Experiments were made with all-metal jets of the appropriate size but it was found that the flames were longer than those obtained with the ceramic tipped jets operating at the same pressure of 2.5 in. w.g. This resulted in flame contact with the base

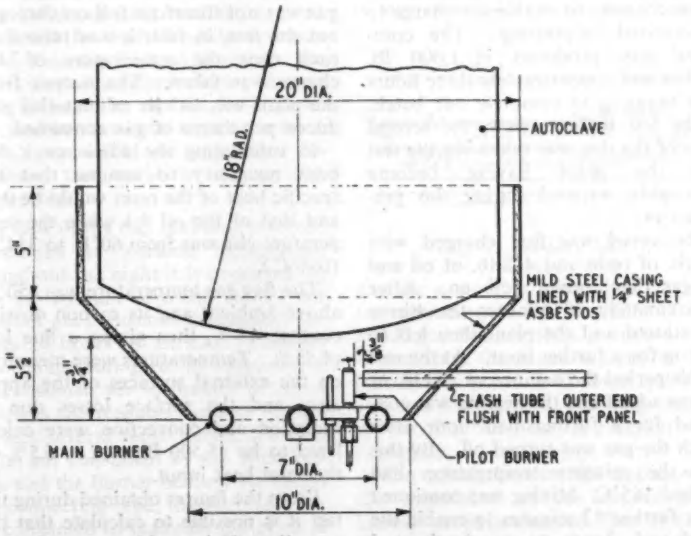


Fig. 5. Combustion chamber—after redesign.

of the vessel and consequent incomplete combustion. The flame contact was eliminated by lowering the burner ¼ in. but in so doing it was then positioned in the opening at the base of the combustion chamber, thus restricting the entry of secondary air for combustion. It was found by experiment that satisfactory combustion was obtained by replacing the frustro-conical portion of the combustion chamber with one having a bottom opening of 10 in. diameter instead of 9 in. diameter as was originally fitted.

BATCH PROCESS

An example of batch process equipment on which tests were carried out at the consumers' premises is to be found in an appliance adapted for a particular process concerned with the manufacture of a proprietary product used in the manufacture of plastic jointing compound. The appliance under test had been built on a pilot scale and it was proposed to use the data obtained from its performance as a basis for the design of a larger appliance for full scale production.

The general arrangement of the appliance is shown in Fig. 6. It consisted of a mixing vessel having curved sides and base and was approximately 3 ft. 3 in. long, 3 ft. 6 in. wide and 2 ft. 9 in. deep. This was heated from beneath by a single bar burner fitted with post aerated jets and located in a refractory lined combustion chamber. The hot gases passed from the burner, round the sides of the vessel through a 2¼ in. wide annular duct formed between the wall of the vessel and an outer asbestos lined mild steel case.

The vessel was fitted with an electrically operated stirrer and also a tilting mechanism to enable the charge to be removed by pouring. The compound was produced in 1,000 lb. batches and approximately three hours were required to complete one batch. In the test under review, the second cycle of the day was taken for the test run, the plant having become thoroughly warmed during the previous run.

The vessel was first charged with 300 lb. of resin and 412 lb. of oil and the gas then turned full on. After approximately 20 minutes the stirrer was started and the plant then left to heat up for a further hour. At the end of this period the balance of 288 lb. of oil was added and the heating was continued for a further half hour after which the gas was turned off. By this time the mixture temperature had reached 165°C. Mixing was continued for a further 12 minutes to enable the vessel and charge to reach thermal equilibrium, the latter finally reaching 168°C. The compound was then immediately run off into drums for transfer to another factory for further processing.

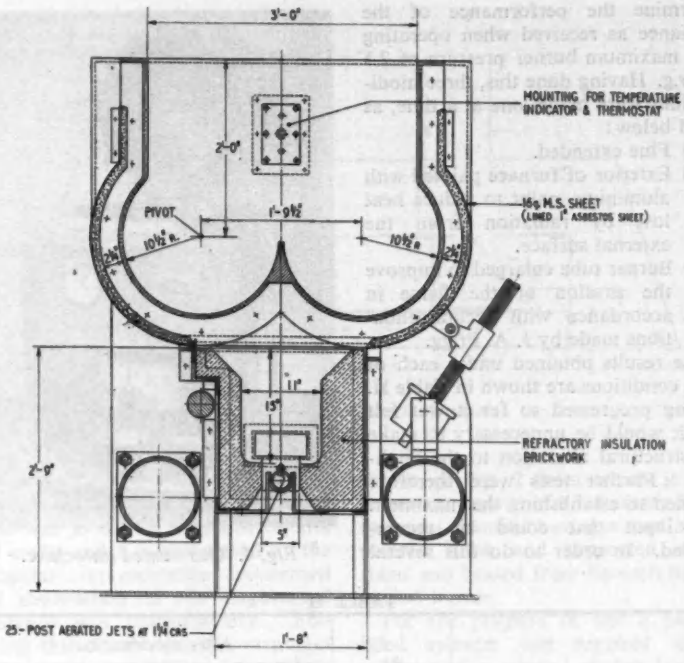


Fig. 6. Mixer.

The period during which the appliance was under test was 2 hours 19 minutes and the maximum heat input during that period was 930 cu.ft. per hour with gas of declared calorific value of 500 B.t.u. per cu.ft. and a burner pressure of 1.5 in. w.g.

PLANT OUTPUT

The total heat input during the test was 1,400 cu.ft. (seven therms). The gas was not therefore full on throughout the test, in fact, it was turned off each time the temperature of the charge was taken. The output from the plant was 143 lb. of material produced per therm of gas consumed.

In calculating the efficiency it has been necessary to assume that the specific heat of the resin would be 0.32 and that of the oil 0.4 while the temperature rise was from 60°F. to 334°F. (168°C.).

The flue gas temperature was 850°F. above ambient and its carbon dioxide content 4.3%, thus giving a flue loss of 53%. Temperatures were measured on the external surfaces of the appliance and the surface losses due to radiation and convection were calculated to be 45,500 B.t.u., *i.e.*, 6.5% of the total heat input.

From the figures obtained during the test it is possible to calculate that the overall coefficient of heat transfer was 4.8 B.t.u. per sq. ft. per hour per degree F. This is a low value, and can be ascribed to the high viscosity of the charge and a low velocity of heating gases relative to the heat transfer surface. Increasing the velocity of the heating gases would probably not increase the rate of heat transfer appreciably because of the importance of the viscosity of the charge.

The flue gas analysis indicates that there is a considerable amount of excess air present which could be reduced by making the area of the flue outlet smaller.

Summarising, these results may be regarded as satisfactory remembering that it is a prototype of plant for a difficult heating job employing equipment designed for other purposes.

LEAD SHEATHING

The second example of work carried out on the district relates to tests carried out in a cable making works for the purpose of investigating the performance of lead melting pots which had been converted prior to the tests, to firing by Hypact burners, the process concerned being the lead sheathing of cables. A general view of the plant is shown in Fig. 7, and working conditions will be seen to be congested.

There were two lead pots, one with a capacity of five tons and the other of 2½ tons, the larger being elevated to such a height that metal from it may be poured into the smaller pot. The metal, in the form of ingots weighing from 50-60 lb. each, was loaded into the large pot for melting and dross

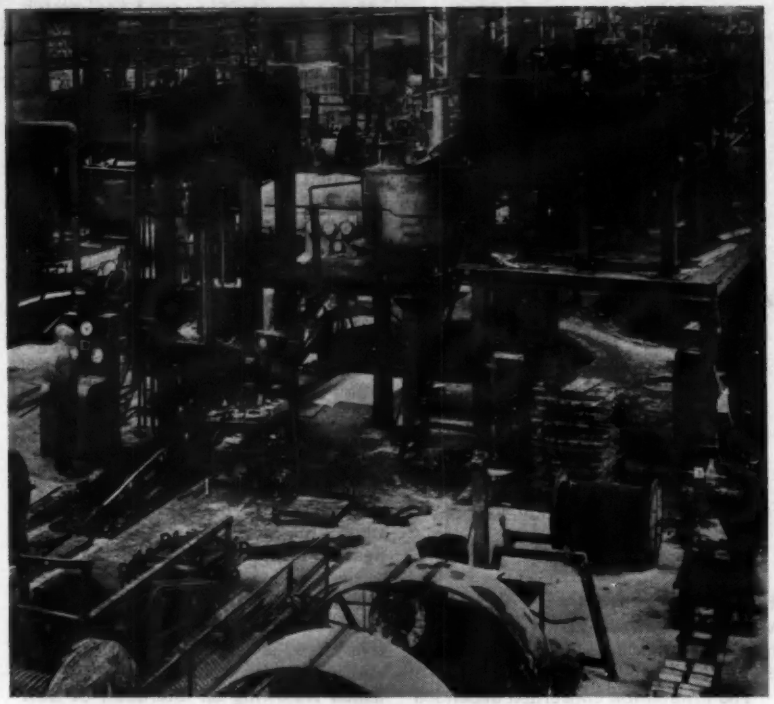


Fig. 7. Cable sheathing plant.

removal and then poured into the smaller pot and maintained at a temperature of 375°C. until required for charging the extrusion press. Both pots were maintained at full capacity and there was a channel through which lead was fed from the larger to the smaller pot which was heated by means of a drilled bar burner fed from an independent gas supply. The lead was charged into the press from the smaller pot by means of a portable trough which was removed after the press had been charged; this trough was not heated.

WASTED PRODUCTION

After a day's working both lead pots were charged to full capacity and maintained at the working temperature of 375°C. throughout the night. Experience had shown that if the pots were allowed to cool overnight the contracting lead tended to creep past the valves, eventually cooling and solidifying, thereby completely stopping up the valve. When this occurred the lead had to be melted out of the valves with hand torches, thus wasting time and holding up production.

The lead sheathing was applied to the cable by means of the press which contained a die and was maintained at a temperature of 200°C. by means of air blast gas jets in series playing on its outer face. When changing the dies and in other exceptional circumstances it was possible that the lead in the die would solidify and prevent dismantling operations. To overcome this an air blast gas hand torch was available.

Tests were carried out to determine the efficiency of the plant (a) in terms of tons of metal melted per therm of gas consumed, and (b) the amount of gas consumed per yard of cable sheathed. It will be apparent that the amount of metal melted per cubic foot of gas consumed varied according to the type of cable being sheathed, *e.g.*, the larger diameter cables will require more metal per yard run, hence more metal will be melted while less gas would be required to maintain the metal at temperature before it was used; if there was a breakdown, however, and no metal was used for several hours, gas would be consumed to maintain the metal at its working temperature.

In view of the fact that the pots were maintained at working temperature throughout the night it is important to note the amount of metal melted per therm of gas consumed throughout the whole 24 hours of the day. Another factor contributing to the variation of gas consumed per lb. weight of metal melted is the frequent need to change the dies several times during the day.

The gas consumed by the pilot supplies and the burner heating the valves and connecting pipe, together with the gas consumed to maintain the press at temperature have not been included in the test figures as those supplies were unmetered, but it should be borne in mind that the heat so supplied did contribute to the process, and in the case of the pilots under the pots, it was understood from the operators that these were almost sufficient to maintain the temperature at equilibrium.

The information obtained during these tests provided a useful guide to the performance which may be obtained from lead melting pots operating in conjunction with similar processes and also gives a value for utilisation efficiency.

REDUCING OXIDES

The case of a plant used to reduce metal oxides can exemplify the activity of the laboratory as a design office.

The chemical reduction of metal oxides to give the parent metal is an old and well-established process but it is only within comparatively recent times that continuous reduction techniques have come to the fore. With the even more recent development of powder metallurgy and the rapidly-growing demand today for metal powders, processes for the production of metal powder from finely-divided oxide feeds have been developed. Some of these processes are continuous, and many are carried out in a reducing atmosphere produced by the endothermic cracking of town gas and air mixtures.

Iron oxide powder can be reduced with solid carbon or by the use of reducing gases, and continuous processes are used, involving rotating-hearth or rotary kiln furnaces. It was the task of the laboratory on one occasion to calculate whether or not a rotary kiln of the type shown in Fig. 8 would carry out the duty demanded of it in reducing 2 cwt. per hour of feed. It was intended that the feed would

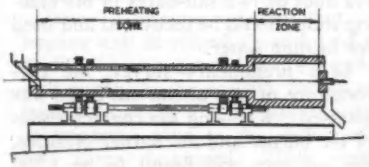


Fig. 8. Rotary kiln.

contain a suitable amount of carbon for reduction, so that the duty of the direct gas firing system proposed was to maintain the reaction zone at the reaction temperature of about 1,100°C. and to maintain a reducing atmosphere, for the heat of reaction was negligible.

The calculations carried out showed the importance of the surface heat losses, which accounted for 74% of the total heat developed by combustion. The endothermic heat of reaction being negligible, only 12% of the

total heat developed would be required to heat a throughput of two cwt. per hour. Because of the need for dilution of the products of combustion by town gas and not by air, the gas rate concerned was 1,340 cu.ft. per hour.

Since the proportion of heat required to heat the material throughput was so small, a recalculation was made for a throughput of five cwt. per hour. The surface heat losses then accounted for 61% of the total heat developed by combustion, with 25% required to heat the powder. The total gas rate required increased to only 1,615 cu.ft. per hour.

It was calculated that the air:gas ratio required would be 2.88 and a suitable burner was designed by the industrial gas engineer concerned, constructed in the industrial workshops, tested in the laboratory and eventually installed.

When the furnace was put into commission in the consumer's premises, the industrial representative involved reported that with a gas rate of 1,500 cu.ft. per hour, 6-8 cwt. per hour of work could be put through while the reaction zone remained at 1,100°C. The surface temperature of the casing round the reaction zone was also approximately as predicted.

This case shows how an unusual problem was tackled by the laboratory, using existing knowledge on a similar subject, and how valuable confirmation of the calculations made was subsequently provided by personnel on the district concerned.

WASTE HEAT

It was the opinion of a works manager that the waste heat passing up the flues of two salt-baths in his blueing shop should be recovered and used for heating water.

In a preliminary survey, the performance of one of the salt-baths was assessed. Knowing the characteristics of the burner and the burner pressure, the gas rate was found to be 1,200 cu.ft. per hour. Analysis of the flue gases by means of an Orsat apparatus showed that the carbon dioxide content on a dry basis was 11.4%, and the temperature of the flue gases at the base of the flue was found by the use of a suction pyrometer to be 1,120°F. Assuming reasonable values for the water vapour and carbon dioxide produced by combustion of gas, application of equation (2) of I.G.D.C. report 430/50 (50/2/39) 'Calculation of Flue Loss,' D 083 shows that heat lost in the flue gases represented 35% of the heat input.

The surface temperature of the flue

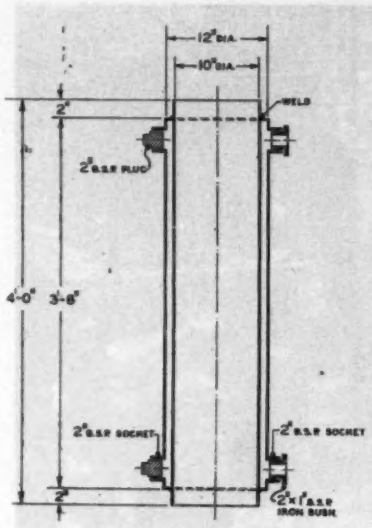


Fig. 9. Annular water jacket.

itself, as measured by a contact-type surface pyrometer, varied from about 600°F. at the base to about 450°F. at the top.

The installation concerned depended on natural draught to exhaust the products of combustion from the aerated burners, so that if the flue were to be obstructed by the introduction of a heat exchanger the combustion would be adversely affected, and the same would be true if too much heat were to be extracted from the system by a heat exchanger. For these reasons it was decided to provide annular water jackets with the same internal dimensions as the flues they replaced. Such a water heater is shown in Fig. 9.

The waste heat available in a practical system is that which can be recovered without condensation occurring. It can be calculated that the dewpoint of the products of combustion in the salt-bath tested was 140°F. and so the heat that must inevitably be lost from the system is 11.8% of the total heat input. Since the actual flue loss was 35%, it is theoretically possible to recover no more than 23.2% of the total heat input, that is, in this particular case, 139,000 B.t.u. per hour.

Tests were carried out on one of the waste heat recovery units. Arrangements were made so that the hot water produced could be diverted from the hot water tank supply line to a bucket. The output of the heat recovery unit was found for different flow rates and the results are shown in graphical form in Fig. 10. In this figure the heat extraction is plotted against outlet temperature, the latter variable being dependent on flow rate.

Since the water flow rates through the heat recovery units were comparatively low, a long time elapsed before equilibrium conditions were established following an alteration of flow rate. For this reason, it was impracticable to determine the amount of heat extracted when the temperature rise in the water was 120°F., as assumed for the original calculations. An extrapolation can be made, as also shown in Fig. 10, which indicates a heat extraction rate of 21,500 B.t.u. per hour.

It was stated by the operators that the installation of these heat recovery units had not interfered with the heating of the pots.

The predicted heat extraction was 14,000 B.t.u. per hour, while that

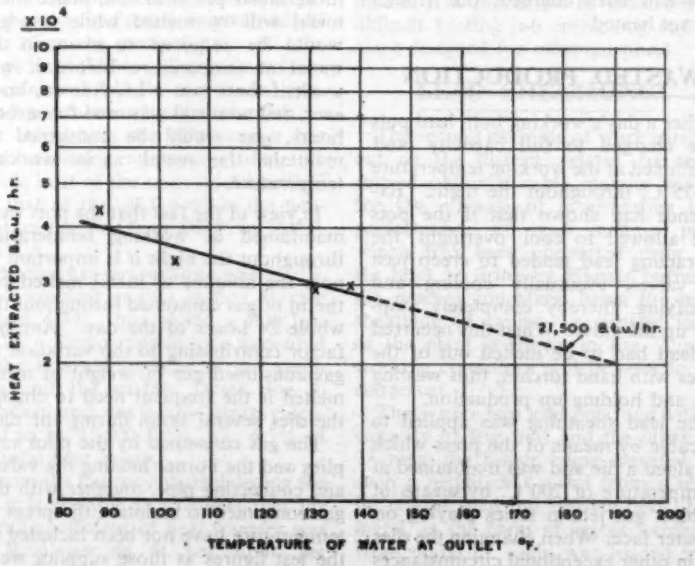


Fig. 10.

determined for conditions comparable to those assumed for the calculation was 21,500 B.t.u. per hour. The calculations, however, neglected radiation.

The eonomic position was an interesting one. The heat recovery units cost £30 each, and at a water temperature rise of 120°F., they will extract about 21,000 B.t.u. per hour each. If the efficiency of a water heater is taken as 70% the heat input equivalent to this saving is 30,000 B.t.u. per hour. Allowing for interest on capital outstanding at an increase rate of 5% and for a cost of gas of 14d. per therm, the units would pay for themselves in 240 working days of 8 hours per day, i.e., in less than a working year.

This case is interesting in that it shows the way in which a waste heat recovery problem can be tackled, using fundamental work on heat transfer. The experimental work carried out after the installation had been made was of value in showing that the initial assumption, that radiation could be neglected, was in error, and similar work carried out by the laboratory in the future will benefit from the experience gained.

BANANA RIPENING

A large firm concerned with the importation, ripening, distribution and sale of bananas was not satisfied with existing methods of heating ripening rooms. At that time ceramic-tipped jets, protected by a wire cage were used, subject to thermostatic control. By itself such a system does not always give a suitably even temperature distribution within the ripening room, although temperature and humidity conditions are critical, especially for the type of banana now imported, and so the firm concerned had introduced into a number of their rooms a fan intended to equalise the temperature. Furthermore, considerations had been given to the incorporation of fan and heater into a single unit, and it was for help in developing such a unit that contact was made with the Industrial Laboratory. This approach was particularly welcome because the need for work in this field had also been appreciated in the gas industry for some time, though it had proved impossible to obtain the necessary facilities.

It was, therefore, with pleasure that the laboratory accepted an offer to make available rooms actually used to ripen bananas, and work was thus carried out at one of the firm's depôts. It was thought necessary to establish the conditions obtaining in a ripening room by measuring:

(a) The temperature distribution throughout the room;

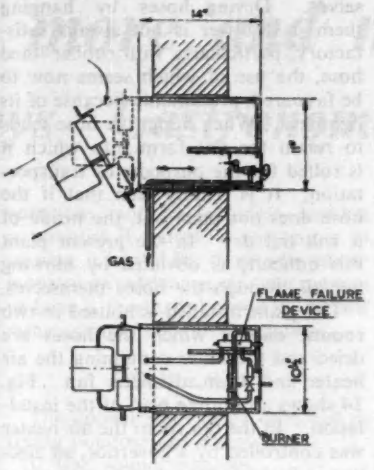


Fig. 11. Banana room heater incorporating fan.

(b) the rate of heating up in the room;

(c) the humidity distribution throughout the room (the attainment of a high relative humidity is held to be essential in banana ripening practice);

(d) the ventilation rate in the room. (This has a direct bearing on the ability of gas to provide the necessary humidity by release of water vapour during combustion.)

The rooms in which the tests were carried out were 7 ft. high, 8 ft. wide and 20 ft. from front to back. With a heating arrangement consisting of ceramic tipped jets protected by wire cages, a vertical temperature variation of 19°F. was found in an empty room while, when the room was loaded, a vertical temperature gradient of 6°F. was found. The temperature range in a horizontal plane at the centre of the room was 6°F. whether the room was loaded or not.

Determinations of the ventilation rates in two rooms showed that 1½-2 air changes occurred every hour with the room shut. This implies an air flow rate of the order of 2,000 cu.ft. per hour which is considerably more than the 100 cu.ft. per hour, or less, necessary to support combustion of 15-20 cu.ft. per hour of town gas required for the burners. Under these conditions a relative humidity of about 85% is obtained in a loaded room, although the value recommended in the literature is higher.

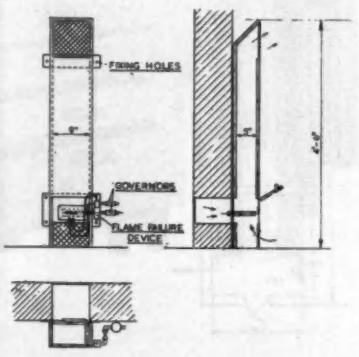


Fig. 12. Banana room heater.

The first of the units to be developed in the laboratory incorporated a fan of the type the firm concerned intended to use in their ripening rooms. The fan was of the reversible type, so that hot air could be sucked out of the room to retard ripening or to prepare the room for the next load. The heater evolved is shown in simplified form in Fig. 11. The full on gas rate given by this heater was 20 cu.ft. per hour, and when installed in a loaded room, the average gas rate was found to 9 cu.ft. per hour. The vertical temperature gradient in a loaded room was found to be 5°F., while the horizontal range was 1°F. The ventilation in a loaded room was only 0.5 air changes per hour, and while this was quite sufficient to support combustion, the humidity attained was quite high, at 86-92%.

SHELVED

These results were considered to be encouraging, but complications arose when an interlock between the gas and electricity systems was sought to go beyond providing for electricity or gas failure and to control the unit both automatically and effectively. For this reason, and also because of the expense of the unit, the question of development beyond the prototype stage has been shelved temporarily.

When it became apparent that the heating unit described above would be costly, it was suggested that a simpler unit might also be evolved, and so the heater shown in Fig. 12 was designed at the same time as the earlier unit was being developed. This heater does not incorporate a fan, but could be used with advantage in a room in which a fan is placed. It can be seen from Fig. 12 that the three jets used fire through holes in a steel plate so that the ventilating air is the minimum required for combustion and so also that the maximum use is made of the air available.

The products of combustion entrain air from the room at the base under the influence of the flue pull engendered in the appliance and so are expelled at the top with sufficient velocity to give some degree of mixing with the bulk of the air in the room.

Fig. 13. Banana room heater.

The full-on gas rate was about 30 cu.ft. per hour, but when installed in a loaded ripening room the average gas rate was only 5 cu.ft. per hour under the thermostatic control. With three jets in the heater the vertical temperature gradient was 2°F. and the horizontal range of temperature was again only 1°F. The ventilation rate in a loaded room was very low at 0.3 air changes per hour, but sufficient to support combustion. The humidity attained reached the desirable 90%.

Both the heaters evolved can be seen to be an improvement on the practice of using open ceramic-tipped jets, and to give comparably good performance. The simpler unit was considered to be sufficiently developed to hand it over to an appliance manufacturer, and, after some modifications, it is now offered for sale on the open market.

The flame failure device is now fitted horizontally and within the casing. The governors are now also housed within the unit itself. The connection to the gas supply is made through the ¼ in. union elbow also to be seen in Fig. 14; this permits either right- or left-hand connection. Laboratory tests showed that combustion with the rated heat input of 14,000 B.t.u. per hour was satisfactory, and that the surface temperatures attained did not rise above the values permitted by the appropriate standards.

HOSE DRYING

As an example of the sort of work that is carried out on the district, the case may be considered of the drying of hoses in an installation incorporating a direct-fired air heater. The purpose of drying the hoses is not only to afford ease of handling during use but also to preserve the hoses themselves. Drying hoses by hanging them in a tower is not always satisfactory, particularly with rubber-lined hose, the use of which seems now to be favoured, presumably because of its lightness. When hung, the hose tends to retain the flat form into which it is rolled for the purposes of transportation. It is readily seen that if the hose does not open out, the inside of it will not dry. In the present plant this difficulty is obviated by blowing hot air through the hoses themselves.

The plant installed is housed in two rooms, one in which the hoses are dried and the other containing the air heater and 48 in. diameter fan. Fig. 14 shows an outline plan of the installation. In the fan room the air heater was controlled by a governor, an electronic flame failure device, a thermostat acting through a relay valve and a vane type air flow switch.

The drying room is approximately 7 ft. high, 7 ft. wide and 80 ft. long. In the drying room two sets of racks run the length of the room to support the hoses which are attached to the hot air manifold by means of "instantaneous" connectors. Because of the length of the room, no recirculation of the air is employed but the moist air is discharged through a wall directly to atmosphere by a 24 in. diameter fan. It will be seen from Fig. 14 that the air inlet and the discharge from the drying room are separated by the plant itself, thus opposing any tendency for wet air to recirculate.

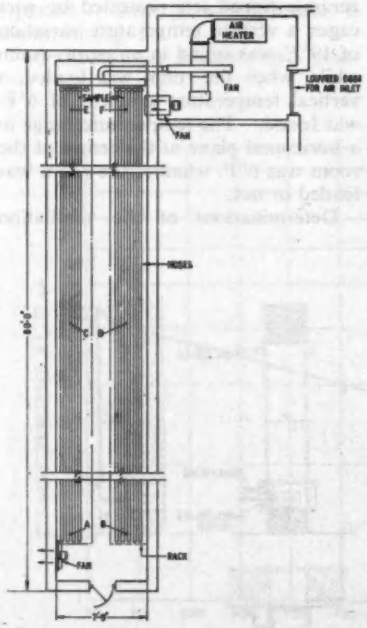


Fig. 14. Plan of hose drying installation.

The hoses used in the tests were 18 lengths of 2½ in. rubber lined nylon hose of nominal length 75 ft. Each hose was weighed as it was taken from store and as it was removed from a water tank after 20 hours' soaking. After rolling, each hose was allowed to drain for about two hours. This, it was thought, gave a test that was severe, yet in accordance with actual practice. After draining, the hoses were weighed and placed in position on the racks in the drying room to provide a full load. Three hoses were taken as samples, all, for ease of handling, from the top racks. The position of these hoses is shown in Fig. 14. The samples were weighed at half-hourly intervals during the first two hours of the test, and thereafter weighings were carried out every quarter of an hour. The test run lasted for 2¾ hours, and at its termination all the hoses were weighed again. Measurements of the gas consumptions were made by means of a check meter installed for the purpose.

VARIED HUMIDITY

Appropriate measurements of temperature, humidity and air velocity were made in the drying room as the tests were carried out. It would be beyond the scope of this paper to give details, but the dry-bulb temperature in the room varied from 50°F. to 98°F. depending on position and time; the mean temperature of the drying room was about 90°F. The humidity and air velocity in the drying room also varied markedly from place to place and from time to time, but at no time did the air become saturated with water. The temperature of the air emerging from the manifold was 130 ± 5°F.

Observations were made of the apparent state of dryness of the hoses during the test. One hour after the commencement of the test they seemed to be dry for the half of the length nearer to the manifold; after 1½ hours about 50 to 60 ft. of each hose appeared to be dry, while after two hours all hoses presented an apparently dry surface.

TABLE III

	Total lb.	Average per hose lb.
Final weight after drying ..	444½	24·7
Water drained away ..	31½	1·8
Water evaporated in dryer	115	6·4
Equilibrium moisture ..	10½	0·6

From the results obtained the drying curve shown in Fig. 15 was constructed and it will be seen that an approximately linear weight versus time curve persists until dryness is

Continued on p. 209

They want more and more chips, says 'Gastronome'

'THEY will eat anything as long as chips are served with it.' This observation was volunteered to me by the catering manager of an old established manufacturing firm a short while ago.

Never before have so many deep fat frying pans of all kinds, makes and sizes been on the market at one and the same time. Among this galaxy of frying equipment are some very fine gas models; in fact it is of great satisfaction to know that they top the bill. Not very many makers' names appear, but those that do have the edge on our fuel competitors' models and more appliances I believe are on their way. To the gas industry in general this is good news, anything that keeps us abreast of competition is welcome, but to those of us who take a particular interest in catering in industry it is of considerable importance, in view of the truth in my catering manager friend's remarks.

No passing phase

The popularity of chipped potatoes at meal times has been with us for too long to be dismissed as a passing phase. But chipped potatoes must be fried properly to be appetising and nutritious, and as first-class cooking is essential if industrial catering is to survive, it is well for those who advise industry on catering equipment matters to have a thorough knowledge of this rather simple cooking operation.

Golden rules

The golden rules to be observed in frying potatoes are sevenfold:—

1. Use sound potatoes.
2. Use a high quality vegetable or animal fat.
3. Avoid too much delay between preparation and cooking.
4. If blanching is to be done, avoid delay between this operation and the final cooking.
5. Do not put the potatoes into the pan until the fat is at the predetermined 'cooking' temperature (340°F. to 370°F.) according to the type of oil or fat.
6. Do not reduce the temperature of the fat by putting too large a batch of chips in at a time.
7. Keep the fat clean and free of crumbs.

A sound potato is one that is reasonably free of bruises, eyes and cuts, with a water content sufficient to keep it in a fresh and hard condition.

A counter unit by Oliver Tom's Catering Equipment Ltd., embracing two Frymasters equipped with thermostat and auto-timer.

The quality of the fat is important. One that has a high smoke point (420°F. to 500°F.) is likely to hold its frying property—that is the attacking of the surface of the potato during frying—longer than one with a lower smoke point. The flavour of the fat and its edibility must be considered important. Remember, a large proportion of this oil combines with the outer part of the cooked chipped potato and is consumed—in fact, it is the characteristic taste that makes the fried potato so popular, or otherwise. A good quality fat will keep its clearness longer than that of a poor quality one, and in consequence it helps to give desirable finishes.

Often blanched

The prepared raw chipped potatoes are often blanched or part cooked so that the colour does not deteriorate and to shorten the time that the final fry will take. It being bad practice to blanch overnight, it follows that the best way to do it is as a two-stage cooking operation, one following immediately upon the other. This calls for speed in frying and maintaining the required high temperature throughout the whole of the cooking time. The basic requirements of a fryer, therefore, is that its B.t.u. imput should be high in relation to the bulk of fat, and that the heat transfer should be so designed that the greatest amount of B.t.u. imput be used in reheating the fat to the desired temperature. The ideal is to cook batch after batch of potatoes with no intervals of waiting for the fat to regain its heat.

Process often rushed

It is a fault in cooking, unfortunately common with many cooks, that the process is rushed. They will either place a batch of chips in the pan before the oil is at the right temperature, or they will have too many chips in the batch. Either will result in slow cooking with a limp, soggy chip as a result.

The capacity of a batch should be pre-determined by the maker of a fryer, who should base this amount upon good, practical cooking and not output for output's sake. It is realised that this may place him at a disadvantage when competing against makers of fryers using a different fuel who claim an output not always related to

normally accepted data. But claims based on sound results usually pay off in the long run and we can truthfully say that for correctly cooked output per area of floor space taken by the pan, gas is in the forefront. It is important that this fact be widely known, both by the catering trade and, more particularly, by the industrial caterers.

Development leaped ahead

The development of gas-heated fryers has leaped ahead in recent years, particularly the smaller pans occupying little floor areas, and our appliances are well ahead in the field of deep fat frying. In design they usually incorporate a 'cool zone' which may be described as a form of trap or sump in which the oil is not in direct contact with the heated surface of the pan (being below the burner position), and into which the debris of food particles naturally find their way, thereby avoiding being cooked and carbonised which makes the fat dirty and particles cling to the food.

Manufacturers who have designed pans incorporating the cool zones and thermostatic control of quick acting design are:—

The Fatmiza by Modern Metal Products Ltd., which has a 'visual cool zone,' permitting the operator to see the amount of solids entrapped and empty them while the appliance is in operation.

Adams & Sons Ltd., with their Starfish;
Aquafont Industries Ltd., with their Snackmaster;
Benham & Sons Ltd., with their Mark IIIA unit fryers;
R. & A. Main Ltd., with their 91F fryer;
Modern Metal Products Ltd., with their Fatmiza Frylux;
Oliver Toms Ltd., with their Frymaster;
James Stott & Co. Ltd., with their unit fryer;
and John Kelly & Co., with their Visidial.

Appropriate appliance

The appropriate appliance will provide 25-70 lb. of fried potatoes per hour, starting the process with a raw chip and with a two- or three-fold increase in the final fry if 'blanching' is done. Such an appliance will be needed where the number of meals falls within the 75-200 category; with higher numbers it would be possible to keep to single units with a 'blanching' operation, but as this would occupy more time and subsequent labour cost, it would be economically preferable to specify the use of duplicate pans.

SPEED

that Frying Job with the

FRYLUX FATMIZA

The Visual 'Cold Zone'

Exclusive to the FRYLUX and protected by patents is the special design known as the visual cold zone, which being made of glass allows the operator to see at once the amount of solids entrapped, so that at any time, even while the FRYLUX is in operation, he may turn off the drain valve, empty away the unwanted solids and replace the zone all with the minimum of trouble or guesswork and thus keep the bulk of frying oil as clean as possible.

VITAL STATISTICS

- 40 lb. of chips per hour.
- 18 inches square.
- 36 inches high.

For further particulars:

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It should be clearly understood that although the pans referred to have been classed as chipped potato fryers, a number of other foods can be cooked in them with equally good results. However, it is this insistence upon chips with main courses served in the industrial restaurant that spotlights these pans for the job. They are fast, fat temperature is controlled, and they are clean in operation. The larger fryers are in many cases equal to the task and, indeed, where the existing installed equipment lacks speed, its usefulness can be augmented by one of these smaller appliances.

The need in industrial restaurants is for chips, more chips and still more chips. The gas industry has the equipment, equal to, and in many cases superior than, that of others. It is a market that must and can be consolidated.

THE LABORATORY IN INDUSTRIAL GAS PRACTICE

From p. 206

reached. This means that a constant rate of drying was maintained until dryness was reached, and the absence of a falling-rate period in turn means that the process of drying these hoses is, as might be expected, solely one of evaporation of water held on the surface of the material. Further, as the constant rate was maintained despite the variations in conditions in the drying room, the factor controlling drying is the transfer of heat to the hoses from the hot gases passed through them.

DRYING TIME

The overall results of the tests on all the hoses can be summarised as in Table III.

Examination of Fig. 14 shows that all hoses are dry in approximately 2¼ hours. It may, however, suffice to dry the hoses down to the moisture content they attain at equilibrium in store. As shown in Table III, the average hose weighs 24.7 lb. dry and contains 0.6 lb. of water under storage conditions, that is, the moisture content is 2.4% on the dry basis. The dotted line in Fig. 14 corresponds to this moisture content, and the drying time can be seen to be just under two hours, corresponding to the visual observation that the hoses appeared to be dry after two hours.

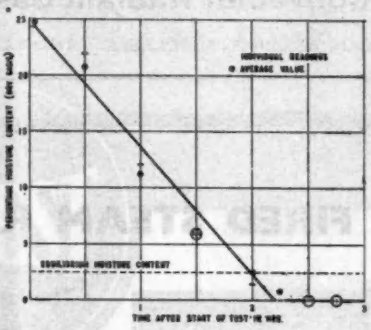

Fig. 15

THERMAL EFFICIENCY

If a drying time of 2¼ hours is taken, and this is generous, the gas consumption to dry the load of hoses was about 1,500 cu.ft. per hour. As 115 lb. of water was evaporated in the dryer, the thermal efficiency is 16.6%. This low efficiency is inevitable in a system in which the air is not reheated, but thrown away after passing once through the hoses. On the other hand, each hose was dried for a consumption of only 83 cu.ft. of town gas.

The discussion of this paper will be published in a later issue.

Correction

In 'Automatic Control of Town Gas Characteristics,' by Mr. K. A. Steele, published in the November 5 issue of 'GAS IN INDUSTRY' (p. 181), the formula at the foot of the third column should read:

$$Q = K\sqrt{\frac{hP}{dT}}$$

followed by: 'If the pressure in the system is closely governed, P and the pressure drop may both be regarded as constant. The temperature also may be considered constant.'

Coke featured at Smithfield Show

THE GAS COUNCIL'S exhibits on stand 256 at this year's Smithfield Show will consist mainly of coke-fired appliances which can be used on the farm.

One feature will be a model of the N.A.A.S. farm built sloping tray drier, fitted into a barn, showing how it meets the need for a drier which can be adapted to existing buildings and provide the farmer with a practical drying installation for handling grain in bulk.

Another exhibit will be a full-size furnace and fan unit—the No. 3 coke heater unit rating 30 lb. coke per hour by D. Clark & Company—which can be used with the N.A.A.S. drier, or applied to other types of batch and platform driers.

There will also be a display of domestic coke-fired cookers, boilers, and fires of the latest types.

Overhead space heating is the theme of the gas section of the stand.

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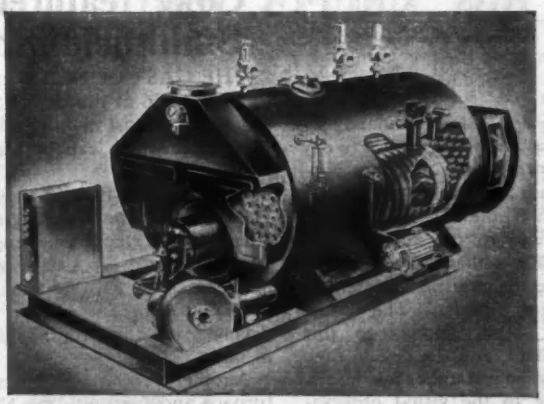

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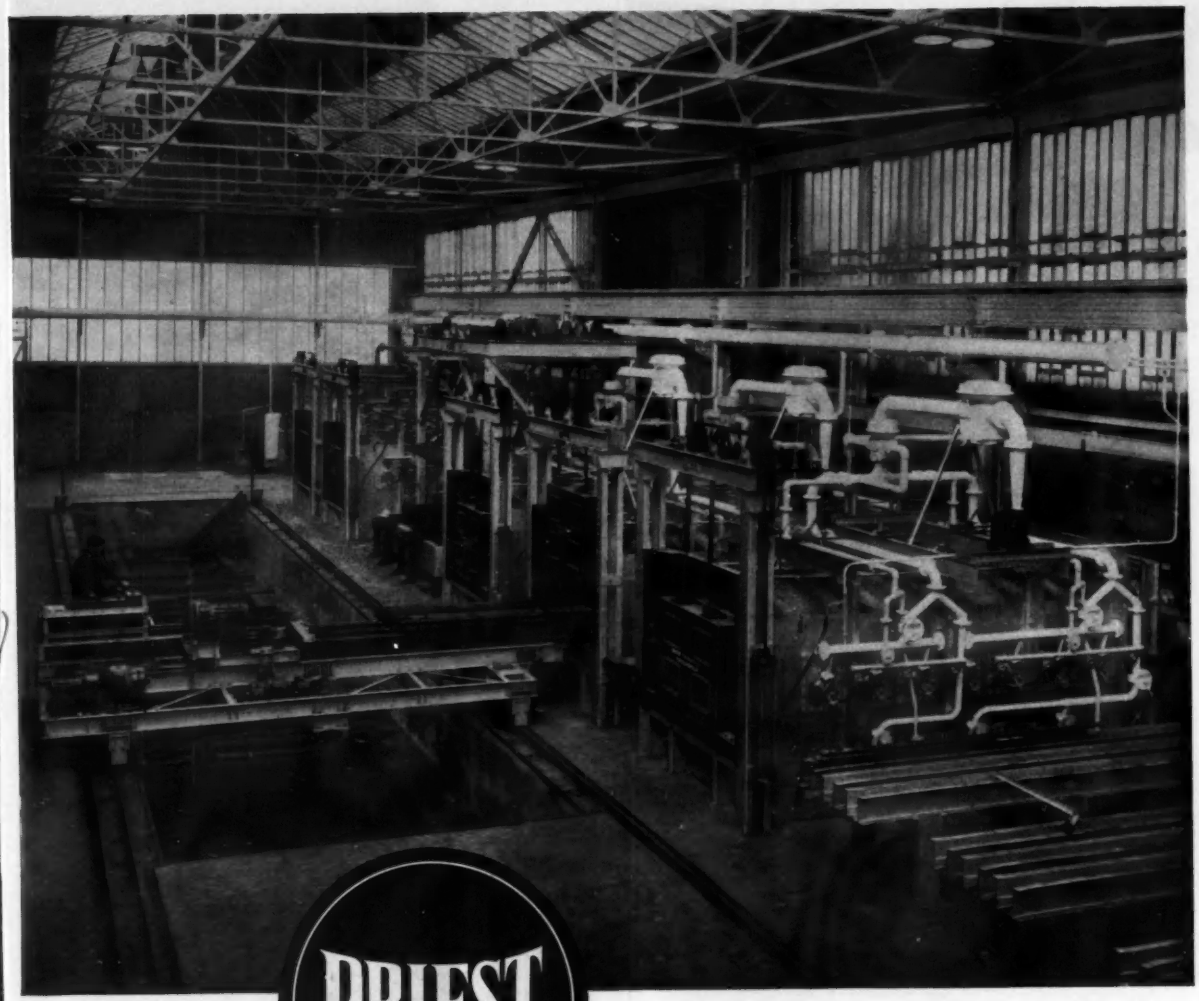

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